The Effect of Dolomite and Chicken Manure on Cauliflower (*Brassica oleracea L.* var. Botrytis) Intercropping with Sweet Corn in Peatlands

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ABSTRACT

Cultivating cauliflower in Central Kalimantan's peatlands requires proper nutrient management. This is because cauliflower is very sensitive to soil and environmental variations, which can affect the growth and mass yield of flowers. Peat soil problems, both physical, chemical and biological, need specific handling, including high soil acidity, poor nutrients, high cation exchange capacity (CEC), with low base saturation, soil pH is generally below 4.5 while cauliflower is a plant that is sensitive to high acidity. The conditions for growing cauliflower plants are between pH 5.5 - 6.6. Low pH and high organic acids do not support plant development and the availability of soil nutrients, so it is necessary to improve peatlands so that they are close to the requirements for growing cauliflower, one of which is by applying ameliorants such as dolomite lime, ash and fertilization.
The purpose of this study was to determine the effect of the type and dose of amelioran on the intercropping pattern of cauliflower with sweet corn on changes in peat soil pH which is most suitable for increasing the growth and yield of cauliflower.
The experiment used a factorial randomized block design, the first factor was the dose of amelioran, which consisted of 3 levels: A_1 = 10 t ha^{-1} burnt ash, A_2 = 3 t ha^{-1} dolomitic lime, A_3 = 6 t ha^{-1} dolomitic lime. The second factor was the dose of chicken manure, which consisted of 3 levels: P_1 = 10 t ha^{-1} chicken manure, P_2 = 20 t ha^{-1} chicken manure, P_3 = 30 t ha^{-1} chicken manure.
Based on the results of this study it can be concluded that the application of dolomite lime amelioran of 3 t ha^{-1} and chicken manure fertilizer of 30 t ha^{-1} on peatlands can improve peat soil pH from 4.1 to 5.1 and increase growth in height, number of leaves and leaf area and flower weight yield of cauliflower plants were 4.59 t ha^{-1} and 5.37 t ha^{-1}.

Keywords: Flower cauliflower, dolomite, chicken manure, intercropping, peat land

PRELIMINARY

The prospect of developing cauliflower plants in Central Kalimantan Province is quite good. In line with the increase in people's income and nutritional awareness, the demand for cauliflower in Central Kalimantan Province continues to increase. So far, to meet consumer needs, most traders bring cauliflower from other areas, especially from the island of Java. Long distances and long enough times resulted in a decrease in the freshness and quality of cauliflower and the price became expensive. Therefore there is a market opportunity to develop cauliflower plants in Central Kalimantan.

Utilization of peat land for cauliflower cultivation has chemical barriers. The main problems in peatlands are soil acidity, nutrient deficiency, especially Ca and high content of Al^{3+}, Fe^{3+} and SO_4^{2-}, cation exchange capacity in peatlands is high and Soil Base Saturation is very low (Tufaila *et al.*, 2014). In addition, the content of micro elements (Cu, Zn and Mo) is very low and is tightly

bound by organic matter so that it is not available to the soil. While the soil pH suitable for growth and mass formation of flowers ranges from 5.5 to 6.5, fertile, sufficient water but not stagnant and rich in soil organic matter. Soil acidity below 5 causes the growth of cauliflower plants to be abnormal so that the mass of flowers produced is small due to a lack of Mg, Mo and B and even some plants are unable to form flowers.

RESEARCH METHODS

Time and Place

The research was conducted on Ombrogen peat soil in Kalampangan Village, Palangka Raya City, Central Kalimantan Province.

Ingredient

The materials used were flower cauliflower seeds of the PM 126 variety, sweet corn seeds of the Bonanza variety, chicken manure and inorganic fertilizers (Urea, SP-36 and KCl), dolomite and burnt ash.

Methodology

The study was conducted using a factorial randomized block design, where the first factor was the type and dose of ameliorant and the second factor was the dose of chicken manure.

The first factor is the dose of amelioran, which consists of 3 levels:

A1 = Burnt ash 10 t ha^{-1}

A2 = Dolomite lime 3 t ha^{-1}

A3 = Dolomitic lime 6 t ha^{-1}

The second factor is the dose of chicken manure, which consists of 3 levels:

P1 = Chicken manure 10 t ha^{-1}

P2 = Chicken manure 20 t ha^{-1}

P3 = Chicken manure 30 t ha^{-1}

Research Implementation

Cauliflower Nursery

Cauliflower seedling is carried out in a prepared nursery. The nursery is given a mixture of chicken manure with a ratio of 1:1. Before sowing the nursery is watered until conditions are moist. Cauliflower seeds are sown evenly then sprinkled with soil thinly, then covered with plastic sacks. After ± 4 days the plastic bag was opened and the sprouts started to grow. The nursery was then given a paranet roof to protect it from heat and rain. Nursery is done until the plants are ready to be transplanted ± 21 Days After Planting (DAP).

Planting Sweet Corn and Cauliflower Seeds

The planting of the sweet corn seeds was carried out 2 weeks before planting the cauliflower, with the aim that the leaves of the sweet corn plant would become a shade for the cauliflower plants. The distance between the sweet corn plants used is 120 cm and the distance in the rows of sweet corn plants is 60 cm, while the spacing of cauliflower used is 60 x 60 cm. Cauliflower plants are transplanted at the age of ± 21 days or already have 4 to 5 leaves.

Provision of Amelioran (Chicken Manure, Ash and Dolomite)

Amelioran (chicken manure, burnt ash and dolomite lime) was applied 2 weeks before planting by spreading it evenly on the row then raking it until it was evenly distributed. The application of the type and dose of amelioran and the dose of chicken manure were adjusted for each treatment.

Cauliflower plants were fertilized using inorganic fertilizers (Urea 200 kg ha^{-1}, SP-36 250 kg ha^{-1} and KCl 150 kg ha^{-1}). SP-36 and KCl fertilizers were given simultaneously at 7 DAP, while Urea fertilizer application was given 2 times at 7 and 21 DAP each half of the dose.

Sweet corn plants were fertilized with 200 kg ha^{-1} Urea, 100 kg ha^{-1} SP-36 and 100 kg ha^{-1} KCl. SP-36 and KCl fertilizers were applied simultaneously at 7 DAP, while Urea fertilizer applications were given at 7, 28 and 49 DAP respectively 1/3 of the dose. The hole where the fertilizer is drilled is ± 5 cm deep with a distance of ± 15 cm from the plant stem, then the fertilizer hole is covered with soil.

Observation

Observation of the growth of cauliflower plants

Observation of growth is done destructively and non-destructively. The observed variables include:

1. Plant height (cm), measured from the soil surface to the top growing point.
2. The number of leaves (strands) per plant, counted all the leaves that have opened perfectly.
3. Leaf area (dm^{-2}), measured using a leaf area meter (LAM).
4. Flower mass yield components of cauliflower plants per plant, per plot and per hectare

RESULTS AND DISCUSSION

Research Result

The results showed that there was no significant interaction between the ameliorant treatment and the dose of chicken manure on the height of cauliflower plants. Administration of ameliorant at various doses had no significant effect on the height of cauliflower plants at 10 Days After Planting (DAP), while a significant effect began to occur at 20 to 40 Days After Planting (DAP). The application of chicken manure at various doses did not significantly affect plant height at 10 to 20 Days After Planting (DAP), but had a significant effect at 30 and 40 DAP.

Table 1. Cauliflower Plant Height Due to The Application of Ameliorant and Chicken Manure at Various Ages of Observation.

Perlakuan	Plant Height (cm plant^{-1}) (DAP)			
	10	20	30	40
Ameliorant (A)				
Ash 10 t ha^{-1} (A_1)	14,60	22,33 a	33,15 a	40,36 a
Dolomite 3 t ha^{-1} (A_2)	15,59	23,21 ab	35,53 ab	41,99 ab
Dolomite 6 t ha^{-1} (A_3)	15,91	24,28 b	36,84 b	44,24 b
BNT 5%	ns	1,51	2,42	3,03
Chicken Manure (P)				
10 t ha^{-1} (P_1)	15,17	22,78	33,47 a	39,64 a
20 t ha^{-1} (P_2)	15,43	23,25	35,21 ab	42,15 ab
30 t ha^{-1} (P_3)	15,50	23,80	36,84 b	44,80 b
BNT 5%	ns	ns	2,42	3,03

Note: Numbers in the same column accompanied by the same letter also show no significant difference in the 5% BNT test

ns = not significantly different DAP = Days After Planting

In Table 1 it is known that the administration of various doses of ameliorant had no significant effect on the height of cauliflower plants at 10 DAP. The application of dolomite (A_2 and A_3) resulted in a higher height of cauliflower compared to the application of ash (A_1) at 20 to 40 DAP, although the application of dolomite 3 t ha^{-1} (A_2) produced a cauliflower plant height which was not significantly different from the application of ash as much as 10 t ha^{-1} (A_1). Increasing the dolomite dose to 6 t ha^{-1} (A_3) increased the height of cauliflower plants compared to 10 t ha^{-1} (A_1) ash, but not significantly different from the dolomite dose of 3 t ha^{-1} (A_2).

The application of chicken manure at various doses did not significantly affect the height of cauliflower plants at 10 to 20 DAP, but had a significant effect at 30 and 40 DAP. Application of chicken manure as much as 10 t ha^{-1} (P_1) resulted in a lower flower cauliflower plant height compared to other doses of chicken manure at 30 and 40 DAP. Increasing the dose of chicken manure from 10 t ha^{-1} (P_1) to 20 and 30 t ha^{-1} (P_2 and P_3) further increased the height of cauliflower plants. An increase in plant height was

obtained through the application of chicken manure as much as 30 t ha^{-1} (P_3), although it was not significantly different from the dose of 20 t ha^{-1} (P_2).

Based on the analysis of variance, it was found that there was no significant interaction between the administration of ameliorant and chicken manure on the number of leaves of cauliflower plants. Administration of various doses of ameliorant had no significant effect on the number of leaves of cauliflower plants at 10 DAP, while at 20 to 40 DAP it had a significant effect. The application of chicken manure at various doses had no significant effect on the number of leaves of cauliflower plants at 10 and 20 DAP, and had a significant effect at 30 to 40 DAP.

Table 2. shows that the application of ameliorants at various doses had no significant effect on the number of leaves of cauliflower plants at 10 DAP. On observation 20 to 40 HST, the application of ash as much as 10 t ha^{-1} (A_1) produced a number of leaves that were not significantly different from the application of dolomite as much as 3 t ha^{-1} (A_2). Increasing the dose of dolomite to 6 t ha^{-1} (A_3) increased the number of leaves of cauliflower compared to the application of ash, although it was not significantly different from the administration of dolomite lime at a dose of 3 t ha^{-1} (A_2) at 30 and 40 DAP.

Table 2. The Number of Leaves of Cauliflower Plants Due to Application of Ameliorants and Chicken Manure at Various Ages Observations

Perlakuan	The Number of Leaves (DAP)			
	10	20	30	40
Ameliorant (A)				
Ash 10 t ha^{-1} (A_1)	7,22	11,00 a	15,39 a	19,72 a
Dolomite 3 t ha^{-1} (A_2)	7,53	11,81 ab	16,39 ab	21,00 ab
Dolomite 6 t ha^{-1} (A_3)	7,80	12,67 b	17,17 b	21,59 b
BNT 5%	ns	1,06	1,12	1,49
Chicken Manure (P)				
10 t ha^{-1} (P_1)	7,20	11,48	15,56 a	19,50 a
20 t ha^{-1} (P_2)	7,44	11,83	16,28 ab	20,92 ab
30 t ha^{-1} (P_3)	7,91	12,17	17,11 b	21,89 b
BNT 5%	ns	ns	1,12	1,49

Note: Numbers in the same column accompanied by the same letter also show no significant difference in the 5% BNT test
ns = not significantly different DAP = Days after planting

Based on the results of the study it was found that there was no significant interaction between the administration of amelioran and the dose of chicken manure on the leaf area of cauliflower plants. At 10 DAP, the application of amelioran and doses of chicken manure had no significant effect on the leaf area of cauliflower plants, whereas at 20 to 40 DAP it had a significant effect.

Table 3. Leaf Area of Cauliflower Plants Due to Application of Ameliorants and Chicken Manure at Various Ages Observations

Perlakuan	Leaf Area (dm^{-2}) (DAP)			
	10	20	30	40
Ameliorant (A)				
Ash 10 t ha^{-1} (A_1)	1,12	5,48 a	34,59 a	61,54 a
Dolomite 3 t ha^{-1} (A_2)	1,14	5,73 ab	37,74 b	69,07 b
Dolomite 6 t ha^{-1} (A_3)	1,17	5,95 b	38,81 b	72,14 b
BNT 5%	ns	0,34	2,77	4,66
Chicken Manure (P)				
10 t ha^{-1} (P_1)	1,09	5,53 a	34,42 a	61,55 a
20 t ha^{-1} (P_2)	1,16	5,66 ab	37,59 b	67,32 b
30 t ha^{-1} (P_3)	1,18	5,97 b	39,13 b	73,89 c
BNT 5%	ns	0,34	2,58	4,66

Note: Numbers in the same column accompanied by the same letter also show no significant difference in the 5% BNT test
ns = not significantly different DAP = Days after planting

In Table 3 it is known that the application of ameliorants at various doses had no significant effect on the leaf area of cauliflower plants at 10 DAP. At 20 DAP, cauliflower plants fed 10 t ha^{-1} ash (A_1) and 3 t ha^{-1} dolomite (A_2) produced lower leaf area than dolomite lime 6 t ha^{-1} (A_3). Dolomite treatment of 3 and 6 t ha^{-1} (A_2 and A_3) resulted in higher plant leaf area at 30 and 40 DAP, while the application of ash at 10 t ha^{-1} (A_1) resulted in the lowest leaf area.

At 10 DAP, the application of chicken manure doses of 10, 20 and 30 t ha^{-1} (P_1, P_2 and P_3) had no significant effect on the leaf area of cauliflower plants. Whereas at 20 and 30 DAP, the application of chicken manure 20 and 30 t ha^{-1} (P_2 and P_3) resulted in wider leaf area, although at a dose of 20 t ha^{-1} (P_2) it was not significantly different from a dose of 10 t ha^{-1} (P_1). At 40 DAP, cauliflower plants that were given 10 t ha^{-1} (P_1) chicken manure produced the lowest leaf area, on the other hand the increased dose of chicken manure from 10 t ha^{-1} (P_1) to 30 t ha^{-1} (P_3)), produced the highest leaf area.

The results showed that there was no interaction between the administration of amelioran and chicken manure on the yield components of cauliflower (Table 4). A single application, treatment of amelioran and chicken manure had a significant effect on the yield components of the cauliflower plant (yield per plot, per hectare and per flower mass). Application of ash as much as 10 t ha^{-1} (A_1) resulted in the lowest weight per mass of flowers and per hectare, namely 186.28 g per mass of flowers or 3.62 t ha^{-1}. The application of ameliorant in the form of dolomite as much as 3 t ha^{-1} and 6 t ha-1 (A_2 and A_3) resulted in higher weight per flower mass, per plot and per hectare than the application of ash 10 t ha^{-1} (A_1). Cauliflower plants treated with dolomite 3 and 6 t ha^{-1} (A_2 and A_3) yielded weight per flower mass of 236.18 g and 259.55 g or 4.59 t ha^{-1} and 5.05 t ha^{-1} respectively.

Table 4. Components of Cauliflower Mass Yield Due to Application of Ameliorants and Chicken Manure at Various Ages Observations

Perlakuan	Flower Mass Yield		
	Per harvest plot (kg 2,16 m^{-2})	Per hectare (t ha^{-1})	Per mass of flower (g plant^{-1})
Ameliorant (A)			
Ash 10 t ha^{-1} (A_1)	1,12 a	3,62 a	186,28 a
Dolomite 3 t ha^{-1} (A_2)	1,42 b	4,59 b	236,18 b
Dolomite 6 t ha^{-1} (A_3)	1,56 b	5,05 b	259,55 b
BNT 5%	0,14	0,51	24,07
Chicken Manure (P)			
10 t ha^{-1} (P_1)	1,05 a	3,41 a	175,24 a
20 t ha^{-1} (P_2)	1,38 b	4,48 b	230,40 b
30 t ha^{-1} (P_3)	1,66 c	5,37 c	276,37 c
BNT 5%	0,14	0,51	24,07

Note: Numbers in the same column accompanied by the same letter also show no significant difference in the 5% BNT test

The application of chicken manure in cauliflower plantations had a significant effect on the yield components of cauliflower plants (Table 4). The lowest yield of cauliflower was obtained when the application of chicken manure was 10 t ha^{-1} (P_1) with yield per flower mass of 175.14 g or 3.71 t ha^{-1}. Increasing the dose of chicken manure from 10 t ha^{-1} (P_1) to 20 and 30 t ha^{-1} (P_2 and P_3) further increased the yield of cauliflower. The highest cauliflower yield was obtained by increasing the dose of chicken manure 30 t ha^{-1} (P_3) with a yield per flower mass of 276.37 g or 5.37 ha^{-1}, although the results were not significantly different from the dose of 20 t ha^{-1} (P_2). Application of chicken manure at 10 t ha^{-1} (P_1) resulted in the smallest flower mass size.

Discussion

The Effect of Amelioran and Chicken Manure on the Growth of Cauliflower Plants

Based on the results of the study it was known that the treatment of giving amelioran with chicken manure did not show a significant interaction with all growth parameters of cauliflower at all ages of observation. The absence of interaction is suspected

because the two ameliorants do not synergize with each other to support growth or it is also caused by one factor playing a more dominant role than the other. If one factor has a stronger influence than the other factors, then the other factors will be covered and each factor is not synergized or does not support each other in carrying out its functions.

Giving ameliorants and chicken manure can improve the properties of peat soil in increasing the availability of plant nutrients thereby increasing the growth of cauliflower plants. The results of soil analysis prior to the study showed that the soil in the study area had low soil pH (very acid), very high organic C/N, high cation exchange capacity (CEC) and very low base saturation. According to Marlina *et al*. (2017), peat soils with very high CEC characteristics and very low Soil Base Saturation percentages will inhibit the supply of nutrients, especially K, Ca and Mg and make it difficult for plants to absorb nutrients. Therefore, to be able to produce good growth and yield of cauliflower plants, it is necessary to apply ameliorant to improve the acidic nature of the soil. The results of the soil analysis after the research showed that the application of ash, dolomite and chicken manure at various doses on peatlands resulted in different changes in soil properties. Abbot *et al*. (2001) explains, the effect of soil change is influenced by the type and dose of ameliorant used.

Changes in soil properties for the better were obtained through the application of dolomite as much as 3 and 6 t ha^{-1} (A_2 and A_3), namely an increase in pH and better base saturation. The application of dolomite as much as 3 and 6 t ha-1 (A_2 and A_3) also causes the availability of nutrients such as K, Na, Ca and Mg to increase compared to ash 10 t ha^{-1} (A_1). This is because dolomite contains Ca and Mg higher than ash. Dolomite (CaMg $(C0_3)_2$) is a type of lime that contains the nutrients calcium carbonate ($CaCO_3$) and magnesium carbonate ($MgCO_3$). Dolomite contains CaO (30.4%), CO_2 (47.7%), MgO (21.9%) and a small amount of iron, manganese, silica and other compounds (0.05%) (Trubus, 2002 in Nopiyanto and Sulhaswardi, 2014). While the ash used in the study had low Ca and Mg contents of 2.52% and 0.34%, and a low C/N ratio so that its effect on changing the properties of peat soils was still less than that of dolomite. Better changes in soil properties through the provision of ameliorants in the form of dolomite will result in better growth of cauliflower plants. The increase in pH due to administration of lime is due to the decarboxylation of organic acid anions such as oxalic acid, citric acid and malic acid which are produced in the breakdown of organic matter.

Application of various ameliorants to peat soils had no significant effect on various plant growth parameters at 10 DAP. Ameliorant treatment at various doses began to have a significant effect on the parameters of plant height, number of leaves and leaf area of plants from 20 DAP to 40 DAP (Tables 1, 2 and 3). There was no effect of ameliorant administration on plant growth at 10 DAP, presumably because changes in soil properties began to occur at 20 DAP. In addition, at 10 DAP, the plants were still in the process of adapting to the environment after the transplanting process, so there was not much formation of new plant organs.

Giving amelioran in the form of dolomite resulted in better growth of cauliflower plants compared to ash. In Table 3 it can be seen that the application of dolomite as much as 3 and 6 t ha^{-1} (A_2 and A_3) resulted in a wider leaf area than the application of ash 10 t ha^{-1} (A_1) at 30 and 40 DAP. Dolomitic lime contains Ca and Mg elements which are higher, where these two types of elements affect the increase in soil pH. An increase in pH can stimulate the activity of soil microorganisms which play a role in the decomposition of soil organic matter, resulting in an increase in plant vegetative growth (Nyakpa *et al*., 1988).

Application of amelioran in the form of ash 10 t ha^{-1} (A_1) resulted in poor growth of cauliflower plants compared to treatments of dolomitic lime 3 and 6 t ha^{-1} (A_2 and A_3). In Tables 1 and 2 it is known that cauliflower plants grown on peat soil treated with ash 10 t ha^{-1} (A_1) produced lower plant height and number of leaves, although not significantly different from dolomite as much as 3 t ha^{-1} (A_2) at 20 to 40 DAP. Meanwhile, Table 3 shows that the application of 10 t ha^{-1} (A_1) ash resulted in a lower leaf area of cauliflower than the application of dolomite 3 and 6 t ha^{-1} (A_2 and A_3) at 20 to 40 DAP. This is due to the fact that adding ash to peat soils is less effective in increasing soil pH and base saturation compared to dolomite due to the low content of Ca and Mg. Low Ca content inhibits the absorption of plant nutrients because Ca is needed to reduce the reactivity of organic acids found in peat soils through the mechanism of forming cation complex compounds and is a macro nutrient needed by plants (Tisdale *et al*.,

1985 *in* Hartatik and Nugroho, 2003). The C/N ratio of ash is also low, namely 6, so that much of the decomposed N has been lost before being used by cauliflower plants. The availability of N in small amounts causes the photosynthesis process to take place slowly and the photosynthate produced is low.

Better plant growth due to the application of dolomite to peatlands is thought to be because dolomite contains higher Ca and Mg than ash. The Mg nutrient in dolomite plays a role in increasing leaf growth so that it will increase the process of plant photosynthesis and produce more photosynthates (Nopiyanto and Sulhaswardi, 2014). The resulting dry matter will be used to enlarge or increase plant organs such as plant height and number of leaves. Therefore, to produce better growth, efforts are needed to widen the leaf area. Wider leaf area will increase the capture of sunlight resulting in more photosynthesis. The photosynthate results are used to form plant organs.

Giving chicken manure can improve soil properties and increase the availability of nutrients for plants so that plant growth increases. The soil at the study site has a very acidic pH, high CEC but low base saturation. Besides that, the C-organic content is high, as well as the total N and C/N are very high. According to Marlina *et al*. (2017), if the total N content, C-organic is high, then N is a constituent of peat organic matter and is not available to plants. In addition, very acidic soil pH, high CEC and very low base saturation result in inhibition of nutrient absorption by plants. Applying chicken manure to peat soil will increase soil pH and base saturation thereby increasing the availability of plant nutrients. Chicken manure can also provide macro and micro nutrients for plants. The results of the soil analysis after the research showed that the application of chicken manure at various doses increased soil pH from pH 4.1 to 5 – 5.5, and increased base saturation from very low (14%) to moderate (30 – 49%), and increase the availability of bases such as K, Ca, Na and Mg. The addition of chicken manure can increase soil pH, total nitrogen, available phosphorus, exchangeable cations and organic matter. Chicken manure fertilizers increase plant growth and yield through improving soil properties and through releasing nutrients into the soil (Adeleye *et al*., 2010).

Tables 1 and 2 show that the application of chicken manure at various doses had no significant effect on the height and number of leaves of plants at 10 and 20 DAP. While on the parameters of leaf area and dry weight of plants, the application of chicken manure had no significant effect at 10 DAP. The effect of chicken manure on the initial growth of plants has not yet been due to the slow release process of decomposition and mineralization of organic fertilizer so that it only starts to have a significant effect after 20 DAP. According to Louisa and Taguiling (2013), the main problem with the use of organic fertilizers is their slow release nature and low nutrient content, so that in order to meet sufficient nutrient requirements for plants, large amounts of organic fertilizers are needed. The degree of N mineralization of organic matter depends on the application dose, C/N ratio, soil characteristics and temperature (Fernandez – Luqueno *et al*., 2010).

The dose of chicken manure had a significant effect on increasing the growth of cauliflower plants. The results showed that the application of chicken manure at a dose of 10 t ha^{-1} resulted in lower plant height, number of leaves, leaf area and plant dry weight. Increasing the dose of chicken manure from 10 t ha^{-1} (P_1) to 20 and 30 t ha^{-1} (P_2 and P_3) further increased the growth of cauliflower plants. Gushan *et al*. (2013) explained that in applying chicken manure, one must pay attention to the dosage. Application of chicken manure at doses that are too low can cause nutrient deficiencies and yields to be low. While the application of chicken manure at doses that are too high can lead to nitrate leaching, phosphorus run off and excessive plant growth. Application of chicken manure at a dose of 30 t ha^{-1} (P_3) resulted in better growth of cauliflower plants. This is because the chicken manure used has a low C/N ratio of 9, so that it can improve soil properties and increase the availability of plant nutrients in large quantities. The low C/N ratio results in during the decomposition process of organic matter, much of the nitrogen produced is lost through evaporation before it can be utilized by plants (Amalia and Widiyaningrum, 2016).

Application of chicken manure at a dose of 10 t ha^{-1} (P_1) resulted in a lower rate of leaf area formation than at higher doses. With increasing doses of chicken manure will increase the leaf area of cauliflower plants. At 40 DAP, the application of chicken manure 10 t ha^{-1} (P_1) produced the lowest leaf area of cauliflower plants, while a dose of 30 t ha^{-1} (P_3) produced the highest leaf area (Table 3). Increasing the dose of chicken manure applied to peat soil can increase soil pH and Soil Base Saturation, as well as

Ca and Mg. Increasing soil pH and base saturation will increase the availability of nutrients for plants. According to Suge *et al.* (2011), the increase in soil pH varies depending on the amount and organic fertilizer used. Increasing the dose of chicken manure further increases the availability of macro nutrients, especially N, which is much needed in early vegetative growth because it is very important for cell division. Nitrogen is a constituent of a large number of important compounds found in living cells such as amino acids, enzymes and nucleic acids (RNA and DNA) (Rop *et al*., 2012).

The ability per leaf area to produce plant dry weight is different for each dose of chicken manure applied. The ability per leaf area to produce dry weight in chicken manure treatment 10 t ha^{-1} (P_1) was lower than other doses of chicken manure. On the other hand, at doses of 20 t ha^{-1} (P_2) and 30 t ha^{-1} (P_3) chicken manure, each increase in leaf area will result in an increase in plant dry weight.

The results of the soil analysis after the study also showed that increasing the dose of chicken manure increased soil pH, saturation and available bases such as K, Na, Ca and Mg. Improving soil properties and increasing the availability of nutrients will increase the rate of plant growth. Organic fertilizers not only provide nutrients for plants but also improve soil properties. Chicken manure fertilizers increase the availability of phosphate in the soil, improve the efficiency of fertilizer use and soil microbial populations, reduce nitrogen loss due to the slow release of nutrients. The slow release of nutrients and the ability to chelate nutrients will fulfill the availability of nutrients for plants for a long time.

The Effect of Amelioran and Chicken Manure on Cauliflower Yields

Amelioran significantly affected the yield of cauliflower plants. In Table 4 it is known that the ash treatment of 10 t ha^{-1} (A_1) and dolomite doses of 3 t ha^{-1} and 6 t ha^{-1} (A_2 and A_3) had a significant effect on weight per plot, per hectare and per flower mass and mass diameter flower. The highest yields were obtained by using dolomite at 3 and 6 t ha^{-1} (A_2 and A_3). Giving dolomite to peat soil can improve soil properties for the better so that it can increase the availability of soil nutrients. The results of soil analysis after the study showed that the application of dolomite was able to increase peat soil pH and base saturation better than the application of 10 t ha^{-1} ash. Dolomite contains higher Ca and Mg, where Ca is effective in increasing soil pH. In addition, the elements Ca and Mg play a role in accelerating flowering (Marlina *et al*., 2017). Increasing the soil pH makes the availability of nutrients better. In the treatment of 10 t ha^{-1} (A_1) ash, although they both increased soil pH and base saturation, the increase was lower than the dolomite treatment because the ash contained Ca and Mg which were lower than dolomite, and C/N ratio is low so that a lot of N is released which cannot be utilized by plants because it evaporates during the decomposition process of organic matter. This resulted in a lower mass weight of the flowers produced by adding ash compared to dolomite.

Applying dolomite to peatlands produces a higher flower mass weight than adding ash. Table 4 shows that the application of dolomite as much as 3 and 6 t ha^{-1} (A_2 and A_3) resulted in a higher weight per flower mass of 236.18 g and 259.55 g respectively compared to the application of ash which produced a flower mass of only 186.28 g ie increased 27 - 39%. The ability of cauliflower plants to produce flower masses is influenced by the leaf area of the plant. From Table 3 it is known that dolomite administration at doses of 3 and 6 t ha^{-1} (A_2 and A_3) resulted in higher leaf area at all ages of observation. Wider leaf area and supported by improved soil properties will be able to increase the availability of nutrients so that the rate of photosynthesis increases and the photosynthate allocated for the formation of flower mass becomes optimal.

An increase in soil pH will accelerate the process of decomposition of organic matter to produce organic phosphate compounds, which can be converted into inorganic phosphate through more complete decomposition. Element P is very influential on growth and increases crop production and improves yield quality (Nyakpa *et al*., 1988). Application of dolomitic lime 3 and 6 t ha^{-1} (A_2 and A_3) on peat soils increased the mass of flowers produced, respectively 4.59 t ha^{-1} and 5.05 t ha^{-1}. The availability of adequate amounts of phosphate can stimulate root development and improve flower formation.

Giving amelioran ash as much as 10 t ha^{-1} produced the lowest flower mass. Table 4 shows that applying 10 t ha^{-1} (A_1) of ash to peatlands resulted in lower weights per flower mass and per hectare than dolomite, namely 186.28 g and 3.62 t ha^{-1} respectively. The lower ash treatment compared to dolomite was thought to be because the ash resulted in changes in soil properties and a

lower increase in nutrients compared to dolomite. This is because the ash used has a low C/N ratio of 6, so that its effect on improving peat soil properties and nutrient availability is lower. The C/N ratio determines the rate of decomposition and mineralization of organic matter. If the C/N ratio is too low, the released nutrients, especially N, are easily lost during the decomposition process before they can be used by plants. Low N availability results in sub-optimal plant growth.

Table 3 shows that cauliflower plants grown on peat lands which were given as much as 10 t ha^{-1} (A_1) of ash enhancer had a narrower leaf area, this resulted in a narrower area of photosynthesis so that the photosynthetic results that could be used to increase the size and the weight of the flower mass becomes less. Aryanti *et al*. (2016), explained that the increase in available N was influenced by pH, Fe and Al ions, as well as the degree of decomposition of organic matter. In addition, the ash used has a low Ca and Mg content of 2.52% and 0.34%. The low availability of Ca causes flower production to be hampered because Ca has a direct effect on the growing point. Meanwhile, the low availability of Mg makes less chlorophyll formation. Less chlorophyll causes the process of photosynthesis to run slower which has an impact on plant metabolism and protein synthesis.

Applying chicken manure at various doses to peatlands can increase the mass weight of flowers. Based on the analysis of variance, it is known that chicken manure has a significant effect on the mass weight of flowers produced by cauliflower plants. The higher the dose of chicken manure applied to the peat land, the more the weight of the flower mass will increase. The highest flower weight of cauliflower was obtained through the application of chicken manure as much as 20-30 t ha^{-1} (P_2 and P_3), while the lowest yield was obtained through the application of chicken manure as much as 10 t ha^{-1} (P_1) with a weight per flower mass of 175.24 g or 3.41 t ha^{-1}. This shows that each increase in the dose of chicken manure will increase the weight per mass of flowers, and vice versa (Table 4). This is because the higher the amount of chicken manure applied to peatlands, the better the peat soil properties will improve and increase the availability of macro and micro nutrients. Chicken manure contains microorganisms that can break down organic matter so that it can increase the availability of nutrients for plants. The process of overhauling soil organic matter will increase soil pH and base saturation which will have an impact on increasing the availability of nutrients for plants. Increasing the dose of chicken manure also increases the available N, P, K and other microelements. The availability of phosphorus in sufficient quantity is not only important for vegetative growth but also for the formation of flower mass. Increasing the available P elements will further increase the mass weight of the flowers produced. Increasing the available K will improve the quality of the flower mass produced. Lack of K in cauliflower plants will produce a mass of flowers that are small and not dense/compact. In addition, element K is needed to maintain the balance between nitrogen and phosphate fertilizers. The availability of K, Ca and Mg elements is the main limiting factor for plant growth and production on peatlands (Alwi and Hairani, 2007). Therefore, increasing the dose of chicken manure from 10 t ha-1 to 30 t ha-1 increased the mass yield of flowers from 3.41 t ha^{-1} to 5.37 t ha^{-1}, which was an increase of 57%.

Application of chicken manure at low doses on peat soils produces a low mass weight of cauliflower. This is because cauliflower plants get the availability of nutrients in low amounts compared to applications with higher doses. The results of the soil analysis after the research showed that the available K, Na, Ca and Mg nutrients were lower than the higher doses. Lower nutrient availability results in lower formation of plant organs such as leaves. Narrower leaf area and less availability of nutrients will result in a slower process of photosynthesis.

Efforts to increase the yield of cauliflower in the lowlands on peatlands, it is necessary to improve the growing environment, not only the micro-environment on the ground but also in the soil. As we know that the nature of peat soil is fragile so that it can experience land degradation/decreased function, if it is mismanaged. In order to increase the productivity of peat soil, the application of ameliorants in the form of dolomite and chicken manure in the right composition and dosage can increase fertility and improve the properties of peat soil and overcome the problem of peat soil acidity. According to Koesrini and William (2009), land amelioration is an effective way to improve soil fertility. The pH of peat soil which was originally only 4.1 increased to 5 – 5.5 after being applied with dolomite 3 - 6 t ha^{-1} and chicken manure 30 t ha^{-1}.

CONCLUSIONS

Conclusion

a. Applying 3 t ha^{-1} of dolomite lime ameliorant and 30 t ha^{-1} of chicken manure on peatlands can increase the pH of peat soil from 4.1 to 5.1 and increase growth in height, number of leaves and leaf area of cauliflower plants.

b. The lowest yield was found in the application of 10 t ha^{-1} ash and 10 t ha^{-1} chicken manure, which produced flower mass weights of 3.62 t ha^{-1} and 3.41 t ha^{-1}, while the highest yield of cauliflower was 4. 59 t ha^{-1} and 5.37 t ha^{-1} were found in the treatment of 3 t ha^{-1} dolomite lime and 30 t ha^{-1} chicken manure.

Suggestion

Based on the research results, it can be suggested that in developing the cultivation of cauliflower in peatlands of Central Kalimantan, it is better to add 3 t ha^{-1} dolomite lime and 30 t ha^{-1} chicken manure, in order to increase the mass production of flowers.

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